Dark Matter, Dark Energy & SNe with MOSAIC and Wider Field Cameras

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Science Drivers
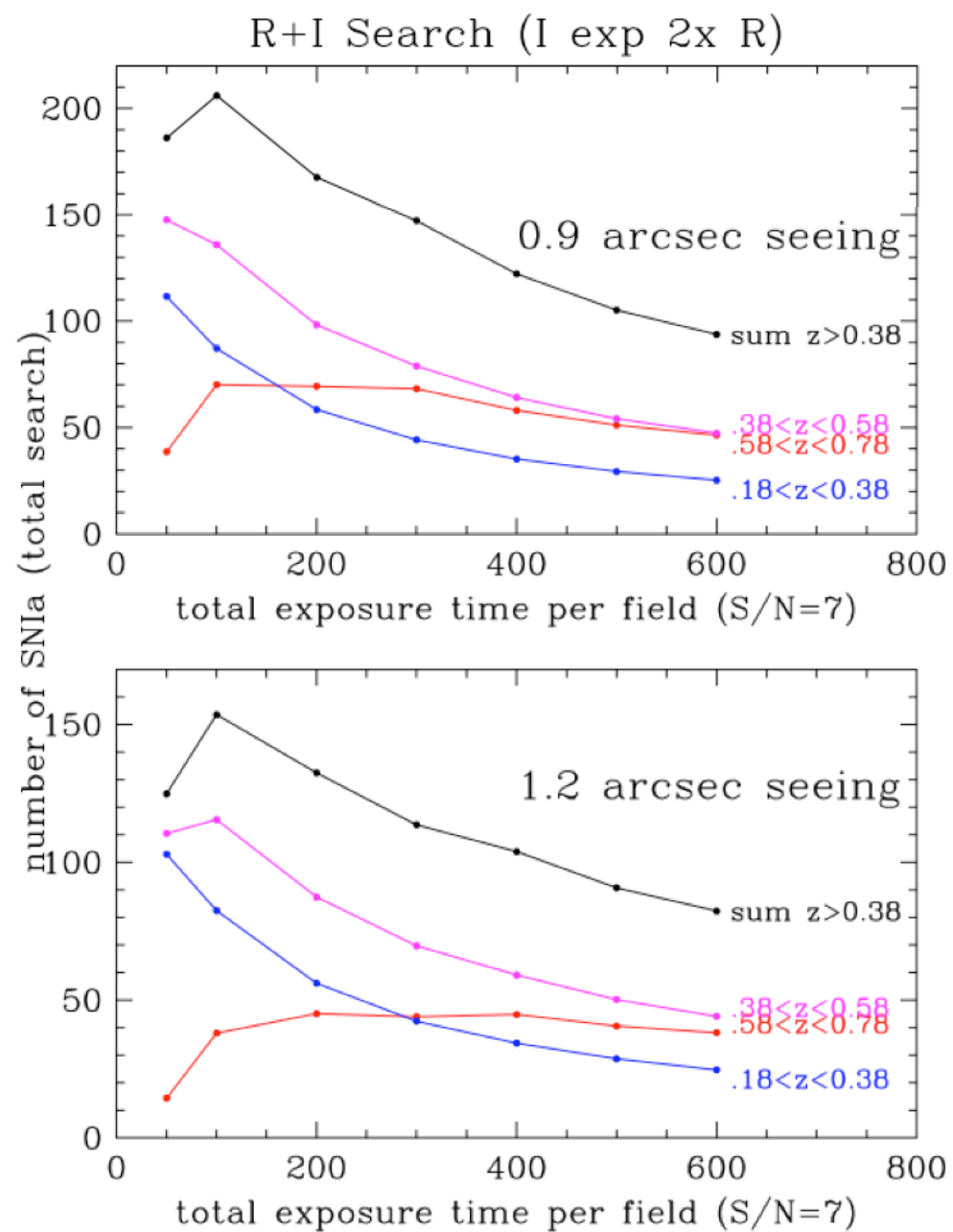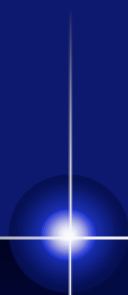
- **DARK MATTER**: SuperMacho

- **DARK ENERGY**: ESSENCE

ESSENCE

- GOAL: Constrain value of w to within about 10%
- Need ~>200 Type Ia SNe: Populate bins of $\Delta z=0.1$ in range of $0.15 < z < 0.75$
- Multiple bands: VRI, R=200s to get out to z~0.8
  - Cover redshift range and SN colors
- ~32 fields = ~12 deg^2
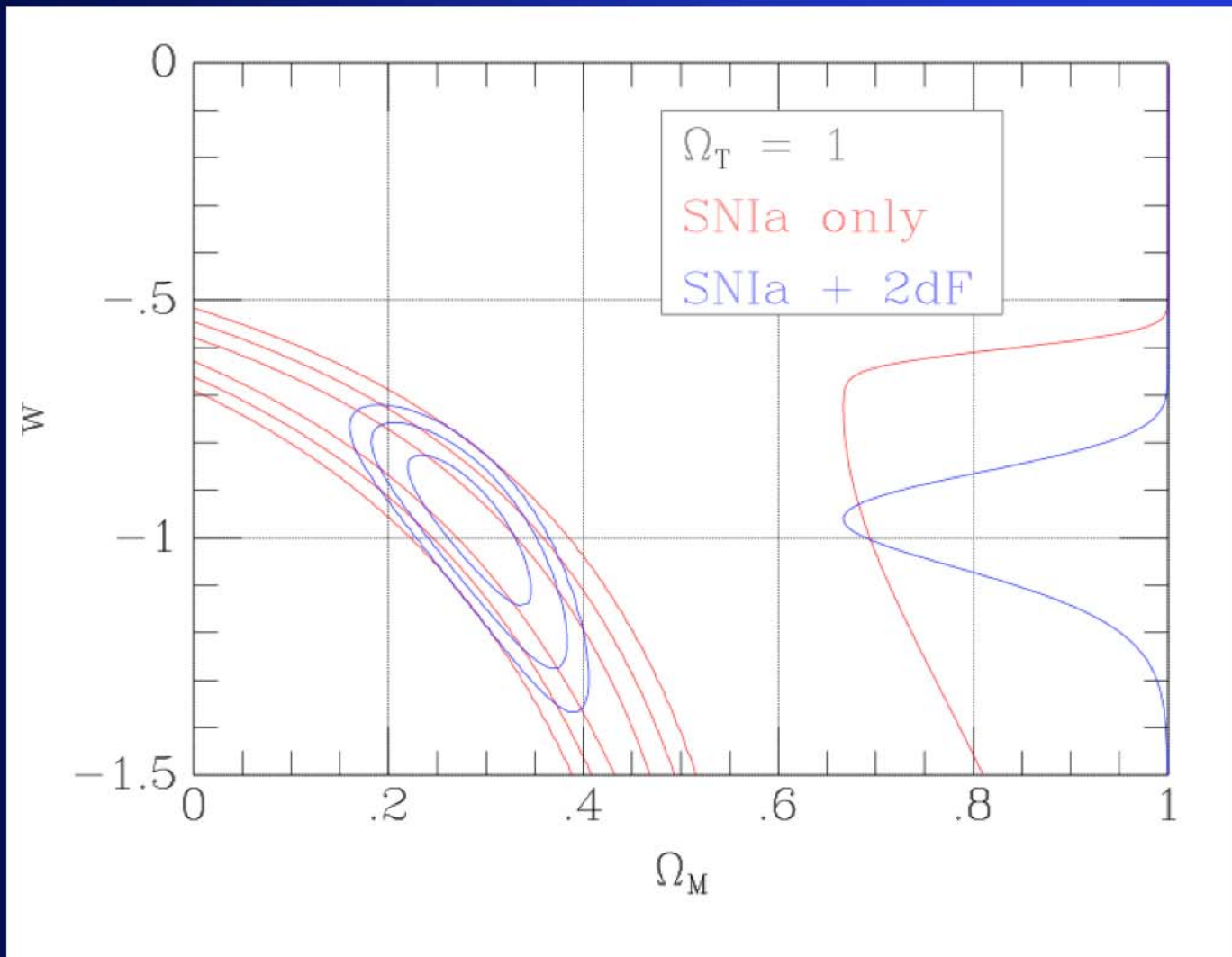- 16 fields in half nights every 4 nights for 3 months
- *http://www.ctio.noao.edu/wproject* or *http://www.ctio.noao.edu/essence*

SN magnitudes as fn(z)

TABLE 7
PEAK MAGNITUDES OF NORMAL SNe Ia

z	B	V	R	I	Z	J
0.05	17.37	17.41	17.36	17.82	17.72	(17.70)
0.10	18.94	18.88	18.80	19.20	19.24	(19.30)
0.20	(20.70)	20.29	20.27	20.36	20.75	(20.96)
0.30	(21.94)	21.08	21.07	20.97	21.28	(21.63)
0.40	(23.07)	21.89	21.62	21.55	21.67	21.97
0.50	(24.06)	(22.59)	22.10	22.01	21.96	22.35
0.60	(24.90)	(23.26)	22.59	22.41	22.37	22.79
0.70	(25.53)	(23.97)	23.06	22.70	22.70	23.06
0.80	(26.00)	(24.75)	(23.54)	22.91	23.01	23.11
0.90	(26.39)	(25.46)	(24.06)	23.12	23.17	23.20
1.00	(26.75)	(26.03)	(24.61)	23.48	23.39	23.25
1.10	(27.08)	(26.45)	(25.14)	23.78	23.50	23.38
1.20	(27.39)	(26.78)	(25.66)	(24.19)	23.72	23.59
1.30	(27.67)	(27.07)	(26.13)	(24.59)	24.11	23.72
1.40	(27.95)	(27.35)	(26.55)	(24.91)	(24.39)	23.94
1.50	(28.20)	(27.60)	(26.93)	(25.36)	(24.70)	24.08
1.60	(28.45)	(27.85)	(27.24)	(25.85)	(25.04)	24.18
1.70	(28.68)	(28.08)	(27.51)	(26.30)	(25.32)	24.32
1.80	(28.90)	(28.30)	(27.75)	(26.77)	(25.72)	24.38

R+I Search (I exp 2x R)

0.9 arcsec seeing

sum z>0.38

.38<z<0.58
.58<z<0.78

.18<z<0.38

total exposure time per field (S/N=7)

number of SNIa (total search)

1.2 arcsec seeing

sum z>0.38

.38<z<0.58
.58<z<0.78

.18<z<0.38

total exposure time per field (S/N=7)
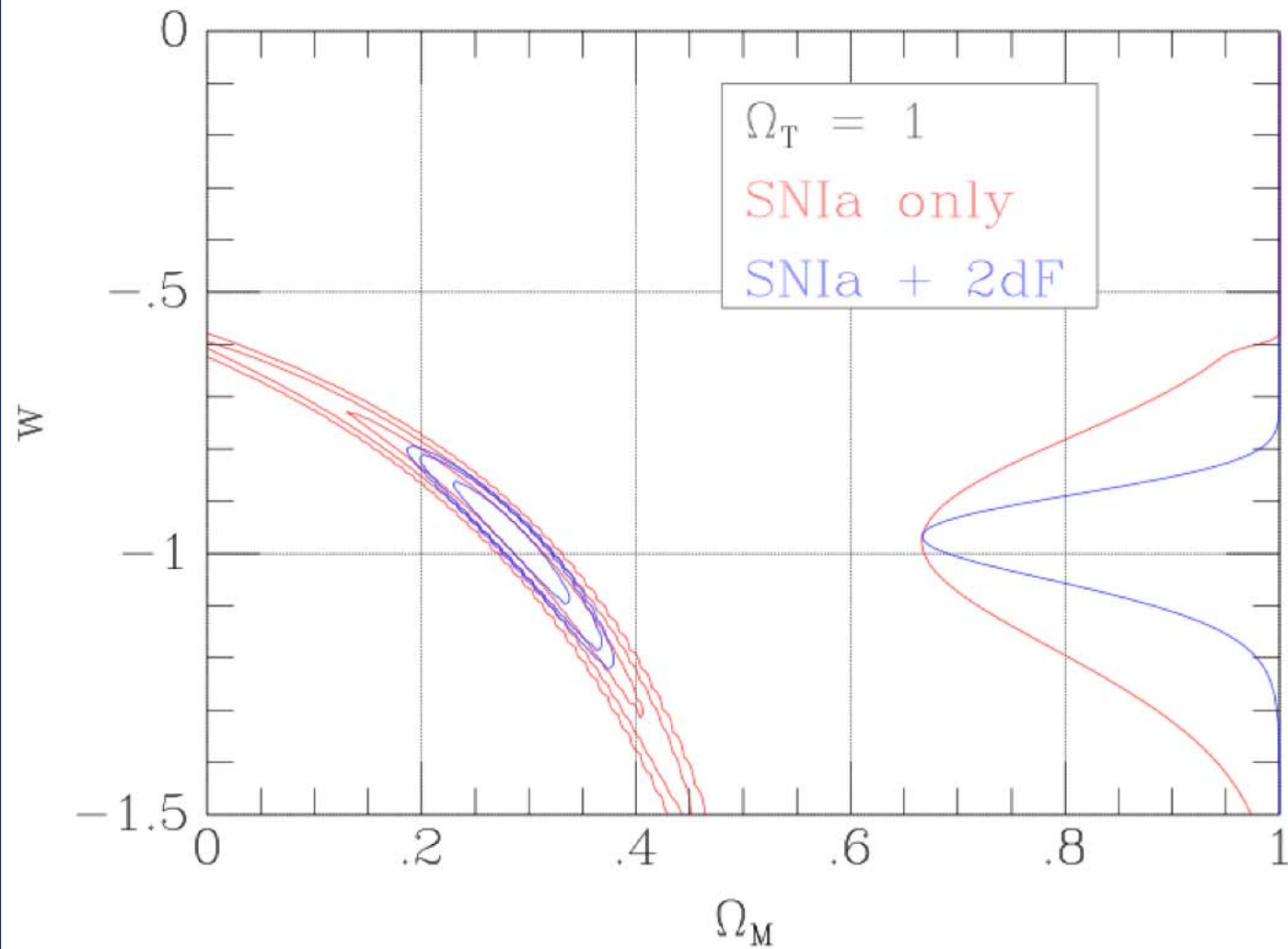
ESSENCE Simulation

Dark Energy Camera SNe

- Science
  - Constrain w (following simulations)
  - Constrain w' (idea… no details yet)
- Simulations
  - Use "Tonry toolkit" to simulate a variety of strategies
  - Toolkit takes parameters survey parameters (sampling, depth, area, etc.), generates SN light curves with appropriate photometric errors, fits them, and derives w contours
  - Gajus Miknaitis ran these simulations for the Dark Energy 2-degree^2 camera

Simulation "2degA"

- Simulation
  - Used same exposure times as current ESSENCE strategy (R,I=200,400s).
  - Tweaked parameters so five 2 sq. deg. fields are imaged every 3 days for 5 years. Assuming a more sane read time of 20 secs, this requires ~1 hour of imaging every 3 nights.
- Results
  - 1194 SNe, out to z~0.8.
  - Error in w looks to be dominated by uncertainty in omega_m, taken to be omega_m = 0.278 +/- 0.042 (i.e. 15%) from 2df
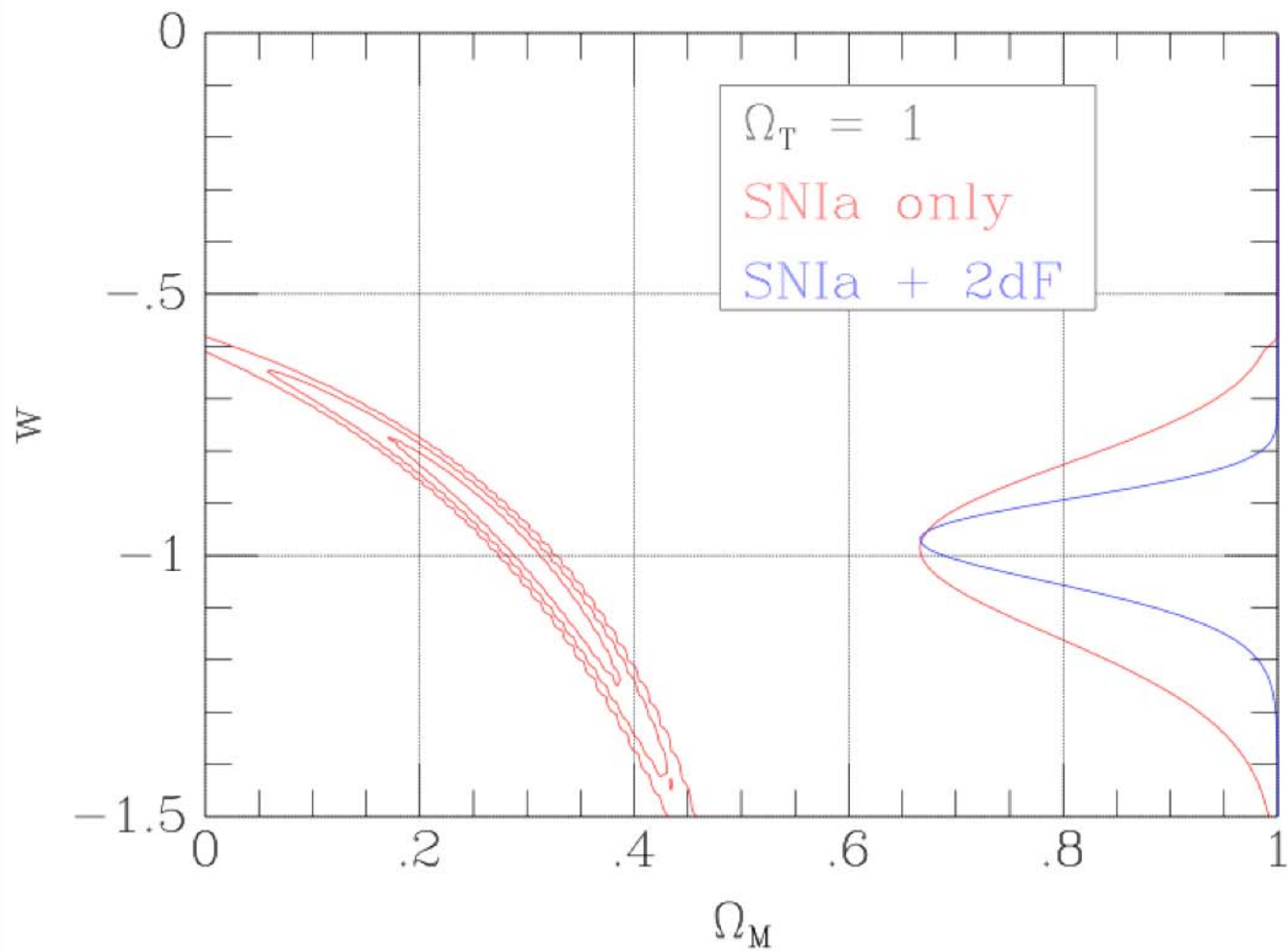
2degA results

Simulation 2degC

- Simulation
  - Same as 2degA (ESSENCE parameters), except double the exposure times in R and I
    - (R,I = 400,800s).
  - This would require ~2 hrs every night.
- Results
  - 1487 SNe, out to z~0.85
  - Very skinny contours, "SN only" constraint approaches joint constraint.

2degC Results

D.E.C. SN Options

- Include SN strategy in base observations
  - Break multiple exposures in SN-friendly way
- Include deeper "pencil beam" fields within 5000 sq.deg. area
- SN program outside of main survey, but done in conjunction with survey allowing for more flexible scheduling
  - Partial nights
  - Portion of night drifting through nights

SUPERMACHO

- Study microlensing towards the LMC
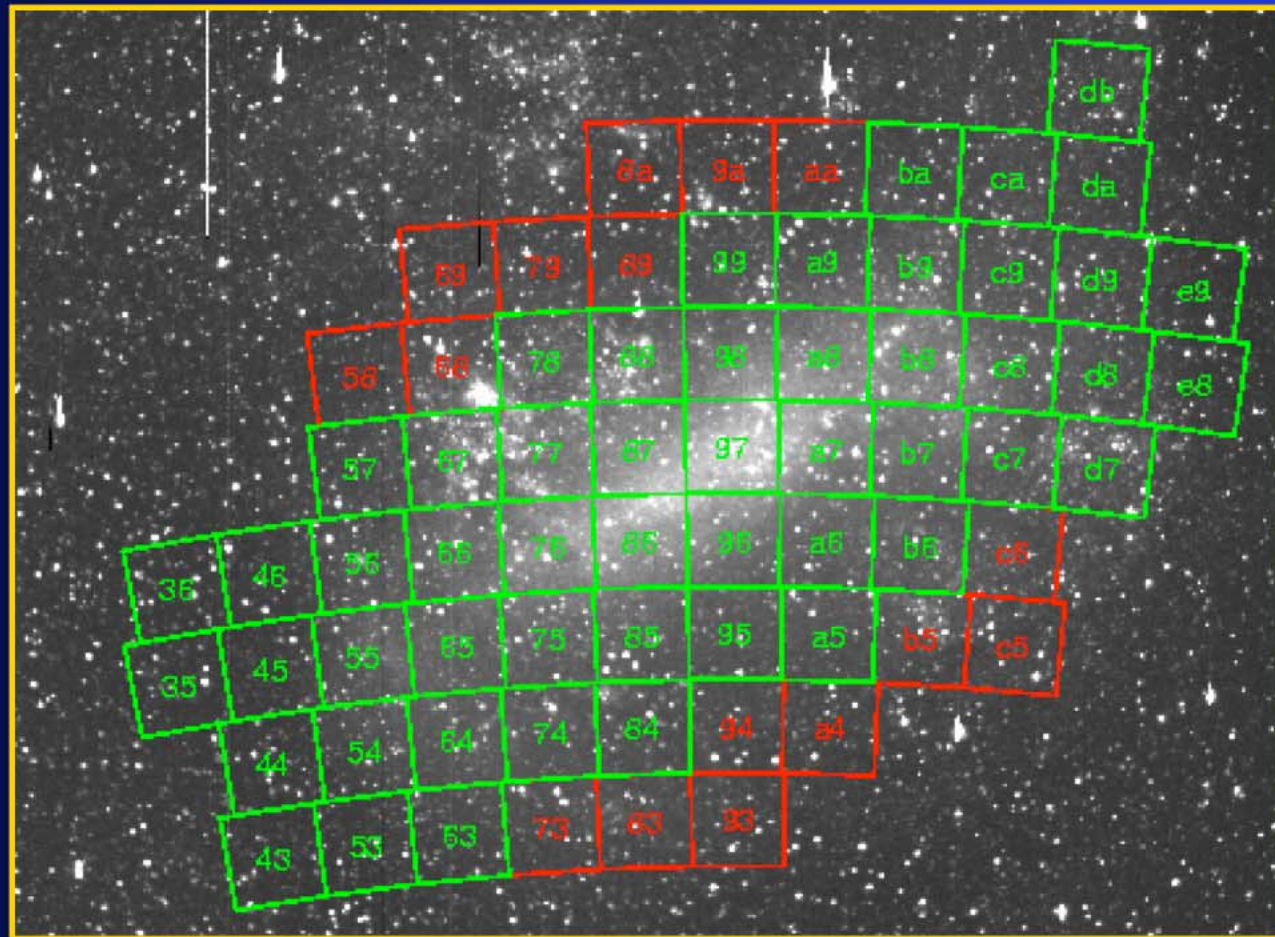
SUPERMACHO

- Goal: Differentiate between whether lenses are in the LMC or Halo
- Need ~50 well-characterized events
- Single band: "VR" = 5200–7200Å
- ~60 fields = ~21 deg^2
- Half-nights every 2 nights for 3 months (Oct-Dec)
- Exposure times optimized to maximize # of stars, ranging from 20s to 200s
- $\sigma = 0.1$ mag at 23rd
- *http://www.ctio.noao.edu/~supermacho*